

A CLINICAL STUDY ON THE VARIOUS METHODS OF RECONSTRUCTION OF SCALP DEFECTS

*Dissertation submitted in partial fulfilment of the
requirements for the degree of*

M.Ch. (Plastic Surgery) – Branch III



**THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI**

AUGUST 2013

DECLARATION

I solemnly declare that this dissertation **“A CLINICAL STUDY ON THE VARIOUS METHODS OF RECONSTRUCTION OF SCALP DEFECTS”** was prepared by me in the Department of Plastic, Reconstructive and Maxillofacial Surgery, Madras Medical College and Government General Hospital, Chennai under the guidance and supervision of the Professor and Head of the Department of Plastic, Reconstructive and Maxillofacial Surgery, Madras Medical College and Government General Hospital, Chennai between 2010 and 2013.

This dissertation is submitted to the Tamilnadu Dr. MGR Medical University, Chennai in partial fulfilment of the university requirements for the award of degree of M.Ch. Plastic Surgery.

Place: Chennai

Date:

ACKNOWLEDGEMENT

I gratefully acknowledge and sincerely thank The Dean, Madras Medical College, Chennai, for granting me permission to utilize the facilities of the institution for my study.

I am extremely grateful to my teacher and guide **Prof. R. Gopinath M.S., M.Ch.** Professor and Head of the Department of Plastic, Reconstructive and Maxillo-Facial surgery Madras Medical College, Chennai, who helped me in all stages of my study. I am thankful to him for his timely suggestions, unending patience, constant encouragement and scholarly guidance.

I also thank my co guides **Prof. Udesb Ganapathy M. Ch.** and **Prof. K. Gopalakrishnan M. Ch.** for their encouragement and expert guidance.

I also thank retired **Prof. K. V. Alala Sundaram M. Ch.** for guiding me in the initial stages of this study.

I express my thanks to Dr. S. Sridevi M.S., M.Ch., Dr. K. Boopathy M.S., M.Ch., Dr T. M. Balakrishnan M.S., M.Ch., Dr. K. Saravanan M.S., M.Ch., Dr.C.Selvakumar M.S., M.Ch., Dr. K. Mahadevan M.S., M.Ch. and Dr. R. Vivek M.S., M.Ch. for their sustained encouragement in my study and work.

I sincerely thank my fellow postgraduates for their help and support which made this study possible.

I dedicate this study to my wife who lent both technical and moral support and was instrumental in the completion of this study.

I am extremely grateful to my parents for their support and encouragement.

Last but not least, I thank all my patients, without their help and co-operation this study would not have been possible.

CONTENTS

S. No	Title	Page No
1	INTRODUCTION	1
2	AIM OF THE STUDY	6
3	REVIEW OF LITERATURE	7
4	MATERIALS & METHODS	16
5	SURGICAL ANATOMY	20
6	SURGICAL TECHNIQUE	26
7	OBSERVATION AND RESULTS	51
8	DISCUSSION	57
9	CONCLUSION	63
10	BIBLIOGRAPHY	
11	APPENDICES	
	• Ethical committee clearance	
	• Plagiarism result	
	• Patient Consent Form	
	• Proforma	
	• Master chart	

INTRODUCTION

The scalp being the superior border of the body, is many a times exposed to insults from the environment. As the scalp usually lacks clothing coverage, it is more commonly susceptible to burns and other trauma that cause extensive disfigurement and scarring. It is also the site for a variety of benign and malignant neoplasms, due to prolonged sun exposure.

The factors influencing decision making in the repair of scalp defects are their size, depth and location.¹ Another vital factor in deciding the management is the nature of the defect. In case of a tumour excision the bone may be removed sometimes requiring a complex reconstructive technique. The type of flap needed to cover the defect is also influenced by the integrity of the surrounding scalp tissue.²

Advancement, transposition and rotation flaps are the work horse flaps for reconstructing these defects. The design of these flaps should consider the preservation of the hairline, aesthetic re-directioning of the hair follicles, the inclusion of major vascular pedicles, and tensionless wound closure.¹

Primary closure is the best option for small defects less than 3 cm in diameter but the location of the defect has to be taken into consideration.³

Total scalp avulsions are devastating injuries that are often caused by long hair getting caught in machinery. The best treatment for scalp avulsion is immediate replantation of the avulsed tissue using microsurgical techniques.

Closure of defects using split-thickness skin grafts is quick and effective. Skin grafting is technically easy and donor site morbidity is minimal.

In case of small and medium size defects local flaps are believed to be the workhorse flaps. These flaps encompass the skin, subcutaneous tissue, and galea aponeurotica. Local flaps are best raised over named vascular pedicles. Skin graft cover for the donor defect once a large scalp flap has been raised is probably the safest procedure.⁴

Unilateral and bilateral rotation flaps are very useful for covering defects in the hair-bearing scalp. Bilateral flaps decrease the wound tension by distributing it over a wider area than single flaps. Forehead defects can also be reconstructed

using rotation flaps producing an aesthetic appearance but can desensitise the adjacent skin.

Transposition flaps are used in the reconstruction of temporal or glabellar defects. Small defects may be covered with a single transposition flap and the donor defect can be closed primarily. This is not possible in case of large defects for which larger flaps are designed. Either a bilobed transposition flap or multiple rhomboid flaps may be designed in these situations.

Multiple flaps have been shown to distribute the tension over the wound. But, multiple rhomboid flaps produce a complicated scar that is difficult to hide along the relaxed skin tension lines.

Orticochea flaps, also called "banana peel flaps," when described initially used four large scalp flaps, each based on a known vascular pedicle. This method allows reconstruction of defects as large as 30% of total scalp area.⁵

A modification of the Orticochea relies on three flaps, two of them are based on the superficial temporal vascular pedicles and a single posterior nape of neck flap based on the

occipital vascular pedicle. The coverage can be increased using multiple scoring incisions in the galea aponeurotica that overcomes the resistance to stretch. This method allows coverage up to 25% of the scalp .⁵

Free tissue transfer provides single-procedure closure of large defects and complicated wounds extending up to the bone. They also provide robust vascularity to the recipient site helping better wound healing especially in cases of defects resulting from radiation exposure and infection.

The disadvantages of free flaps are that they are time consuming, cause significant donor site morbidity, and are expensive for the patient. Therefore, free flaps are indicated only when other simpler reconstructive techniques such as skin grafts, local scalp flaps, or healing by secondary intention cannot be done.

The radial forearm flap is a good choice for resurfacing small defects in which reconstruction of bone is not required.

Another good option for covering such soft tissue only defects is the anterolateral thigh flap.

The latissimus dorsi free flap with its long dominant pedicle and its soft pliable nature is an ideal method of reconstructing large scalp defects.

The reconstruction of scalp defects can be successful if the decision making is based on a good knowledge of anatomy, a meticulous evaluation of the defect, and consideration of the relevant patient factors and the knowledge of the varied reconstructive methods available.

Preoperative planning is important. The planning must be tailored to the individual defect as no single method is available for covering scalp defect.

A successful reconstruction must result in less morbidity, decreased hospitalization time, good aesthetic appearance, preserving the hairline without violating the body contour.

AIM OF THE STUDY:

1. To analyze scalp defects and to discuss the various established reconstructive options available and their application.
2. To evaluate the outcomes of various surgical procedures following scalp reconstruction.

REVIEW OF LITERATURE

The repair of scalp wounds follows a reconstructive ladder according to the size of the defect. The early history of scalp wound management consisted mainly of spontaneous granulation and re-epithelialization. This was later followed by direct approximation of the wound edges to hasten healing.

During the past several years, a better understanding of the blood supply of local scalp flaps, introduction of the technique of tissue expansion, and the advent of microvascular free tissue transfer has greatly improved the ability of plastic surgeons to reconstruct scalp defects.³

In the reconstructive ladder, primary skin closure of small defects is the first option when possible. Other options available for reconstruction are split or full thickness skin grafting, local scalp flaps with or without expansion of adjacent tissue, occasionally regional flaps and free tissue transfer in that order.

Primary closure is a simple method of defect closure with good aesthetic and functional results in small defects, but as the size of the defect increases, primary closure becomes a

more challenging option. Samuel J. Lin et al in 2008 stated that size of the defect is not the only criteria; the tissue that is being advanced for closure and its quality should also be given important consideration .³

Scalp tissue that has undergone radiation will be stiff and is unlikely to advance and close if there is even mild amount of tension in the suture line. Although scalp tissue can bear significant amount of tension during wound approximation, the rigidity which is an inherent nature of the scalp tissue limits the undermining and advancement of wound edges compared to other parts of the body which have comparatively more lax skin. Hoffman JF in 2001 stated that only defects that are not more than 3 cm in diameter can be closed primarily due to the limited elasticity seen in scalp tissue.⁶

Whenever the wound bed is found to be well vascularised split or full thickness skin grafts can be considered as a good option for scalp tissue reconstruction. Netolitzky in 1871 was the first person to reconstruct a scalp defect with skin graft.⁷ In 1908 Robinson found that when the pericranium is intact skin grafting can be done without waiting for the defect to granulate.⁸

Small scalp defects can be resurfaced easily using local scalp flaps or skin grafts (*Gillies, 1944; Conley, 1964*). However deep defects which are extensive and involving the dura are a challenge for the reconstructive surgeon.⁹ Yoon S et al in 2011 reported that a single-stage acellular dermal matrix and split-thickness skin graft reconstruction represents a simple and valuable surgical approach to achieve a durable scalp coverage without requiring donor-site or prolonged treatment.¹⁰

Furnas H et al in 1990 reported the disadvantages of skin graft like impaired colour, and texture especially when it is meshed. He also stated that skin grafting can be done only after several weeks giving time for granulation tissue to appear thereby producing sufficient wound healing conditions. This is especially needed when there is a huge defect lacking periosteum and the underlying bone is exposed with the outer cortical table drilled to produce multiple perforations.¹¹

Robson MC et al in 1989 reported that whenever the resected area is undergoing postoperative radiotherapy split or full thickness skin grafting should not be used as a reconstructive option.

He also stated that postoperative radiation interferes with the healing of skin graft and the chances of developing radiation ulcer are increased manifold. When there is osteoradionecrosis or preoperatively the resection site has been exposed to radiotherapy then defect coverage with skin grafts is a relative contraindication.¹²

The indications and technique of tissue expansion for scalp reconstruction are discussed by Argenta et al, Manders et al and Wieslander.⁷ Radovan popularized tissue expansion of the scalp, enabling recruitment of more hair bearing adjacent scalp.⁸

Cemil Dalay et al in 2006 conducted a study on 15 patients and concluded that tissue expansion procedure led to an increase in hairy areas in the late phase in six of his cases.¹³

Tissue expansion requires a good amount of adjacent tissue that can be expanded, patient should be able to tolerate multiple surgical procedures, and calvarial bone coverage should be stable during the expansion period. But in situations such as malignant scalp tumours where immediate resection

and reconstruction of the scalp tissue is needed tissue expansion is contraindicated.³

Tissue expansion is not a treatment option for malignant scalp tumours such as squamous cell carcinoma or for infected and post traumatic scalp defects as the procedure takes several weeks. In these cases, tissue expanders play an important role in the secondary treatment for aesthetic improvement after reconstruction of the defect.⁴

Manders EK et al in 1984 stated in their study that patients with scalp defects up to 50% of the scalp may undergo expansion of adjacent scalp as an option for reconstruction.¹⁴

Leedy JE et al in 2005 in his algorithmic approach concluded that the scalp tissue at the end of the expansion must be at least 20% larger than the original defect to give allowance for recoil of tissues during advancement or rotation.¹⁵

Kazanjian and others espoused the use of local flaps.⁸ They found that local flaps were the best option in small to moderate scalp defects. Lutz BS et al in 1998 reported that

local flaps can be employed with great success in defects involving the hair-bearing regions.¹⁶

Demir Z et al in 2003 reported that scalp flaps are advantageous in that they are technically simple and 2 or 3 local flaps can be raised if needed if the defect to be covered is large.¹⁷

Garcia – del Campo JA et al in 2008 conducted a study and found that local flap techniques lead to shortening of surgical time compared to the other techniques and the donor site morbidity in the skin graft donor site is minimal resulting in a satisfactory cosmetic outcome.¹

Cornelia Mueller et al in 2012 stated that local flaps have pleasant outcome.¹⁸ Bizhko IP et al in 1992 and Ioannides C et al in 1999 found that the main disadvantages of local flap reconstruction techniques are that they require adjacent normal scalp tissue and they are unsuitable for covering defects in the non-hair bearing forehead region. Also local flaps are insufficient to cover the deep defects of the scalp as the tissue is insufficient.^{19, 20}

The introduction of free tissue transfer for head and neck reconstructive surgery has immensely increased the repertoire of techniques available for reconstructing scalp and forehead defects.²¹

Free tissue transfer of the scalp was first introduced by Mclean in the year 1972 when he covered a scalp wound with omentum. Broad excision of many scalp malignancies results in removal of underlying periosteum as well, leaving the subsequent wound unsuitable for skin grafting.⁸

Camelia Tamas et al in 2005 conducted a study on 14 patients with scalp defects and concluded that the use of a rotation flap, a transposition flap or other types of reconstructive procedure is more often decided by the nature and size of the scalp defect.²

Pennington DG et al in 1989 concluded that free microvascular tissue transfer is a safe and reliable method to reconstruct large defects of the forehead and scalp after resection of a tumour.²²

Hussussian CJ et al in 2002 found that microvascular free tissue transfer has the advantage of covering large

wounds with flaps with robust vascularity in a single-stage procedure, and they are a robust form of scalp defect closure.²³

Cornelia Katharina Mueller et al in 2009 reported that comorbid illnesses, like diabetes or renal failure, habits such as smoking, or prior radiotherapy are predictors of a free flap failure.²⁴

Poeschl PW et al in 2003 found that free flap harvest produces a donor site that is at a distant part in the body and donor-site morbidity has been described to be more than that at the site of the defect.²⁵

Thorwarth M et al in 2008 noted that the flap harvest and the recipient vessel preparation increases intraoperative time and also increases postoperative medical complications. Also, the free flap reconstruction is usually bulky and the reconstruction of defects in the non-hair bearing region produces a poor aesthetic outcome.²⁶

Corradino B et al in 2010 concluded that in case of reconstruction following resection of a malignancy, risk of leaving a residual tumour under the free flap remains.²⁷ Charis

Ioannides et al in 1999 stated that in cases with large scalp defects, free flaps can be the best option to give the best reconstructive and aesthetic result.²⁰

MATERIALS & METHODS

A clinical study was conducted in the Department of Plastic Reconstructive and Maxillofacial Surgery, Madras Medical College and Rajiv Gandhi Government Hospital over a period of 28 months from October 2010 to January 2013.

STUDY POPULATION

The study population in the present study were the patients who visited the hospital for scalp reconstruction.

INCLUSION CRITERIA

The patients with scalp defects due to trauma, infection, burns and cancer resection were included in the study.

EXCLUSION CRITERIA

Those patients who were not willing to participate were excluded from the study.

ETHICAL CLEARANCE

The ethical clearance was given by the Institutional Ethics committee, Madras Medical College.

INFORMED AND WRITTEN CONSENT

Informed and written consent was obtained from all patients prior to the start of the study.

SAMPLE SIZE

A sample size of 20 patients requiring scalp reconstruction procedures was taken.

COLLECTION OF DATA

The data was collected with a proforma regarding patient, defect and treatment related parameters. All the details of the patient that were relevant to the study were collected during the preoperative, surgical and postoperative periods and during follow which was later analyzed.

Procedure

- Detailed history was recorded and all patients were examined clinically.
- Based on etiology, surgery was planned either emergency or elective.
- Patients were taken for surgery under GA and the patient was positioned on the operating table in lateral or prone or supine posture.
- Based on the size of scalp defect, reconstruction was done by:
 - Primary closure
 - Replantation
 - Skin grafting:

- *Split thickness or full thickness graft*

➤ Local flap techniques:

- *Rotation flap*
- *Transposition flap*
- *Advancement flap*

➤ Free flap techniques:

- *Radial forearm flap*
- *Antero lateral thigh flap*
- *Latissimus dorsi free flap*

- Monitoring flap for viability and any complications

Follow up Procedure:

- At weekly interval for one month followed by once a month for 6 months.

Assessment of Outcome:

Post - operative complications were assessed. It can be either donor-site or recipient-site problems.

❖ *Donor-site complications are*

- wound infection
- seroma and
- hematoma

❖ *Recipient-site complications include*

- wound infection
- hematoma
- flap necrosis
- dehiscence
- skin graft failure

STATISTICAL ANALYSIS

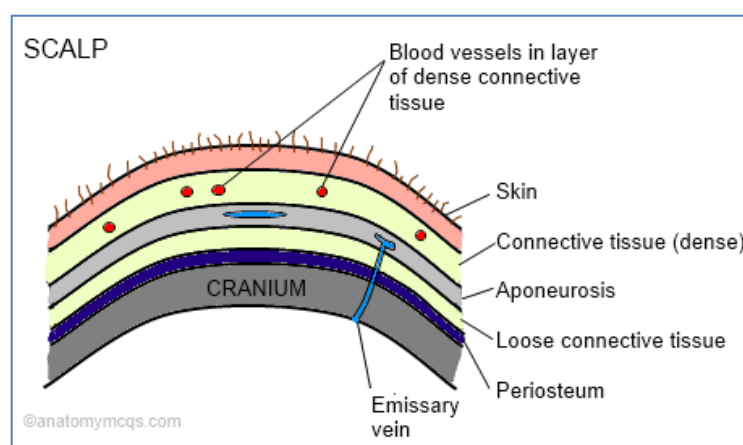
The data collected were analysed at the end of the study.

SURGICAL ANATOMY

Knowledge regarding the anatomy of the scalp is required for designing the scalp flaps as they have to be designed on one or two major blood vessels to allow maximum rotation thereby aiding closure of the defect.

The scalp can be defined as the anatomical area covering the skull extending anteriorly from the superior orbital rims up to the superior nuchal line posteriorly. This anatomic area is further divided into non-hair bearing and hair-bearing regions.

The scalp tissue within this region consists of 5 layers: skin, subcutaneous tissue, galea aponeurotica, loose areolar tissue, and pericranium. These layers can be remembered easily using the mnemonic "SCALP".³



The scalp skin is the thickest skin available in the body. Its thickness ranges from 3 millimetres to 8 millimetres. The

outer layer of thick skin is found firmly fixed to the underlying subcutaneous tissue layer. This layer is highly vascularized and acts as a bridge of fibrous tissue that keeps the skin anchored tightly to the galea aponeurotica below.

The galea aponeurotica is basically a part of the superficial musculo-aponeurotic system or the SMAS layer of the scalp which is nothing but a membranous extension connecting the occipitalis posteriorly and frontalis anteriorly.⁷

The galea aponeurotica gains clinical importance especially in cases of coronal defects that occur through the galea as the frontalis and occipitalis muscles antagonise each other resulting in separation and wide dehiscence of the wound edges. However, if the galea remains intact, retraction of the wound edges does not occur much. Whenever scalp defects are being reconstructed, limiting the separation of the aponeurotica layer from the overlying skin is of paramount importance as this may devascularise the skin.

Laterally, the galea aponeurotica is continuous with the superficial temporal fascia or the temporoparietal fascia. The superficial temporal fascia is a highly vascular layer that encloses many key structures, mainly the superficial temporal

artery and vein, the auriculotemporal nerve, and the frontal branch of the facial nerve.³

Under the aponeurotic layer is a layer of loose connective tissue or loose areolar tissue. This layer allows relative free movement between the galea aponeurotica and the underlying deepest layer, the pericranium. It is also the point of separation in cases of post traumatic scalping injuries.³

The pericranium is a layer that is made of highly dense connective tissue that is tightly fixed to the underlying calvarial bones by means of fibrous connections called Sharpey fibres. These fibres are usually easy to strip away from the underlying calvaria but they are usually strongly adherent in areas of the cranial sutures. At the level of the superficial temporal line the pericranium divides into two layers, the deep temporal fascia or the temporalis muscle fascia and the pericranium of temporal bone. The two layers enclose the temporalis muscle. The temporalis fascia splits and covers the superficial temporal fat pad inferior to the temporalis muscle, and then it gets inserted in the zygomatic arch.⁴

Five major paired vessels from the carotid system enter the scalp symmetrically and interconnect to form an extensive network covering the entire cranium.⁷

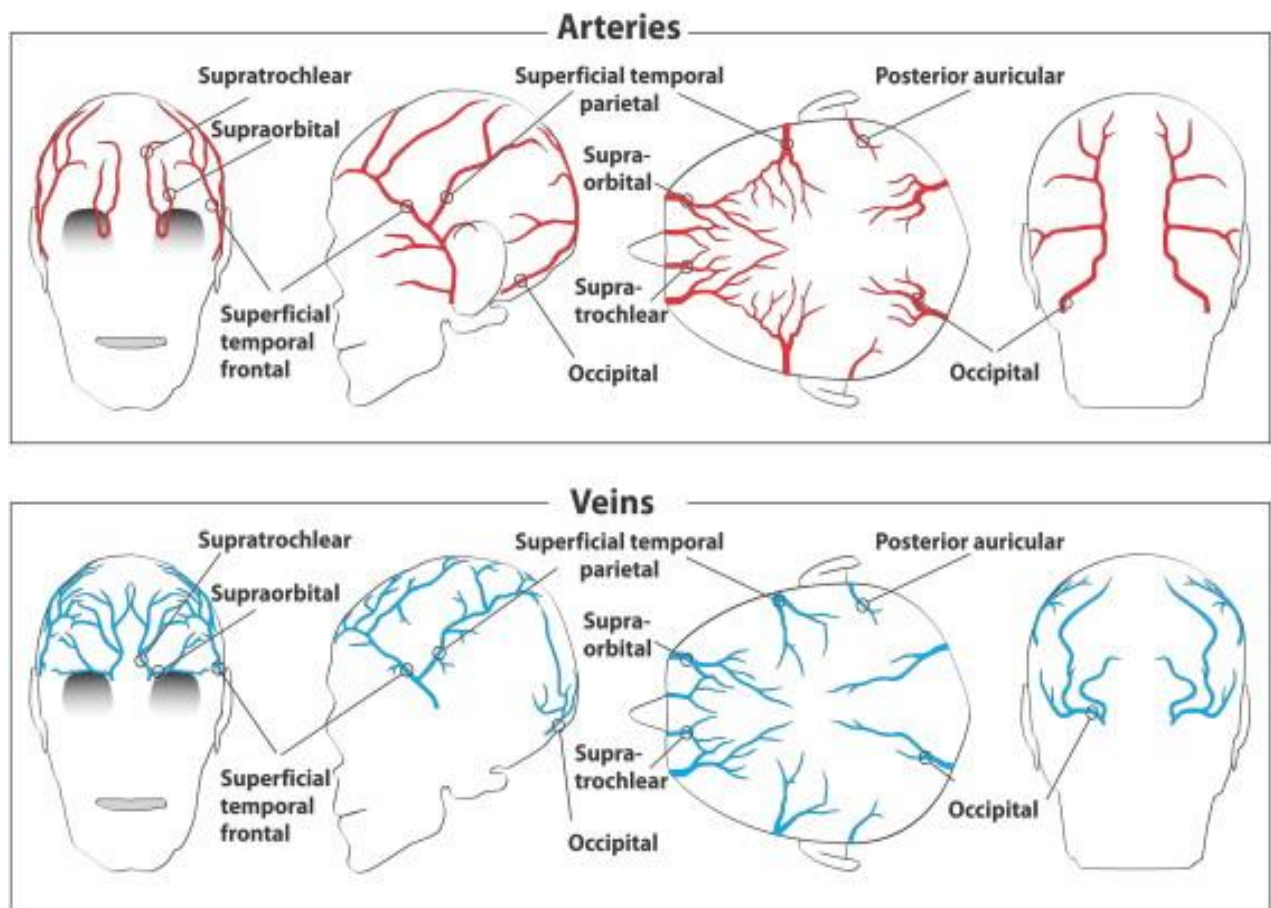
The scalp is arbitrarily divided into four vascular territories. The *anterior* territory includes the supraorbital and supratrochlear arteries, and vessels of the ophthalmic artery from the internal carotid system. The supraorbital vessel frequently leaves the orbit through a small foramen located vertically above the medial limbus in the supraorbital margin. The supratrochlear vessel emerges from a point sited on a vertical line above the medial canthus.⁷

The lateral territory is supplied by the superficial temporal artery, which is the longest scalp vessel and supplies the largest area.⁷

The posterior scalp territory is made up of the two lateral and the two medial occipital artery branches, which enter the scalp at the supranuchal line and course superiorly. The posterolateral territory receives its blood supply from the posterior auricular artery and its branches.⁷

The arteries of the scalp take their origin from the periphery of the scalp and then they ascend towards the vertex. Therefore, the main scalp flaps raised for the reconstruction of the scalp have to be based peripherally. This highly vascular network of the scalp provides the chance for a free tissue transfer or scalp replantation.

The arteries of the scalp and their accompanying veins originate peripherally and ascend to the dome in bilateral fashion; thus, it is preferable to base scalp flaps peripherally. In the younger patient, there is widespread anastomosis of the end vessels at the vertex, which provides greater latitude of safety in flap design, even permitting retrograde flaps based on this rich vascularity at the vertex. This latter advantage is not enjoyed by the older patient in whom arteriosclerosis diminishes these end vessels.



Vascular supply of Scalp

The collateral circulation of the scalp is so ample that a single arterial microsurgical anastomosis is sufficient to maintain viability of the entire scalp, although the frequency of midline crossover decreases after the sixth decade of life.⁷

SURGICAL TECHNIQUE

There are many options available for the reconstruction of scalp defects. Each method has its own role in the reconstructive ladder with its own disadvantages and advantages. What can be the best method of reconstruction for a particular scalp defect can be an impossible choice for another defect.

Thus many factors have to be taken into account before deciding on the method of reconstruction for a particular defect. Stable coverage of the defect and good contour are the main goals in scalp reconstruction.

Primary closure

In case of small scalp defects, primary skin closure is the best option available. If primary closure is used as the reconstructive option, any galeal defect should be closed initially using buried absorbable sutures and wound edges must be approximated using suture materials.

Simple undermining of tissues underneath the aponeurotic layer might decrease tension aiding in the closure of few small

defects but usually undermining does not produce a significant improvement in the case of large scalp defects.

Stretching of the adjacent scalp tissue has shown to provide some extra scalp tissue length. This method relies on the biomechanical properties of the skin such as "creep and stress relaxation". After the skin has been constantly stretched for a minimum period of at least 5 minutes using skin hooks the above biomechanical properties of the scalp skin allows for some amount of permanent skin stretching, but most of the immediate gain in stretch are usually lost.²²

Adequate scalp tissue advancement can occasionally be gained by the use of releasing incisions over the galea or galeatomies. The surgeon has to carefully place these releasing incisions parallel to the adjacent blood supply.

There is controversy in regards to the way these incisions have to be spaced. Some authors suggest leaving 1 to 2 cm intervals while others recommend a 0.5 to 1cm interval. In both these methods, the basic principle is the same i.e. the releasing incisions separate the fibrous structure of the galea which is usually tough thereby allowing for some amount of stretching of the scalp skin.

All the above mentioned techniques for primary wound closure are of limited use when closing any defect that is large in size. Thus, they usually produce a poor outcome by creating excessive wound tension or by producing a precarious blood supply for the healing wound.



Pre – Op



Post - Op

Replantation

First, the scalp hair should be shaved and rinsed thoroughly in running tap water. Next, scalp vessels are identified in both temporal areas. The galea is incised for 2-3 cm to mobilize the vessels. If identified, the supraorbital, supratrochlear and post - auricular vessels are tagged. The

entire posterior margin of the scalp segment is then cauterized with a bipolar.

Next, the patient is anesthetized, the scalp dressing removed, and bleeding vessels are controlled with micro clamps. The scalp is anchored to the head with quilting sutures. All available vessels in the frontal and temporal areas are re-anastomosed. At least one artery and two veins are repaired. Vein grafts are usually not necessary. Nerve repair is not performed, since spontaneous re-innervation occurs.

The following are guidelines for scalp replantation:⁷

- all anastomoses must be outside the zone of injury, requiring vein grafts
- blood loss should be minimized by performing multiple venous anastomoses
- any blood lost must be replaced
- the superficial temporal vessels are most readily accessible for repair by vein grafts, and an entire scalp can survive on a single superficial temporal artery, if necessary
- up to 18 hours of cold ischemia is tolerated without risk to scalp viability

- the hair must be closely clipped to avoid injuring any vessels that may have adhered to it
- arterial anastomoses should be done first if warm ischemia time is >10 hours

Skin grafting and Tissue expansion

Skin grafts may be used for temporary coverage, minimizing wound care issues while preparing the scalp for definitive reconstruction, as during prolonged tissue expansion.

Skin grafting is sufficient for wound closure in several situations, especially in elderly patients whose medical condition does not allow more extensive procedures to be performed or in cases which need close observation and follow up of the wound bed for any tumour recurrence.

Primary coverage with a skin graft, followed by serial excision, is an option for patients not desiring tissue expansion and wanting to maintain a relatively normal hair distribution. Skin grafts may also be used to provide coverage for free muscle flaps to decrease the flap bulk that would otherwise be seen in patients if the muscle and full thickness

skin were transplanted as a single unit as in the case of latissimus or rectus free flaps.

Skin grafts need a good well vascularized wound bed and fail if applied over exposed bone devoid of pericranium. Intact pericranium is a requisite to sufficiently support a graft. Thorough debridement of the wound to remove all necrotic tissue should be done before a skin graft is applied to the wound bed. Meticulous haemostasis of the wound bed should be achieved in order to prevent formation of hematoma underneath the graft, which can increase chances of failure .²³

Skin grafts applied over the scalp are usually not meshed to produce better aesthetic results. It also gives the scalp increased resistance to any shearing force.

Skin grafts finally lead to a poor aesthetic outcome as it produces an aesthetic mismatch as far as skin colour, texture and skin thickness are concerned. Poor cosmetic results are more obvious in cases of defects in the hair bearing region of the scalp. Reconstructing defects with local scalp flaps almost always leads to a better aesthetic result when compared to primary split skin grafting.

Pre – Op



Post – Op



Skin grafting is usually used as a temporary measure, when tissue expansion of the adjacent scalp tissue is done as a means of buying time. Tissue expansion commonly gives adequate tissue that has good scalp sensation, and matches in

colour, thickness, and hair characteristics. The disadvantage is that it usually requires at least 2 surgical procedures.

The surgeon has to place the tissue expanders in the subgaleal plane via incisions placed at a site as far away from the area that will be expanded. When the defect area is grafted the expander has to be placed away from the junction between normal and skin grafted tissue to prevent dehiscence of the wound. Tissue expanders must never be placed under scarred tissue or tissue that has underwent prior radiation.

Filling of the expander is done every week, in small volumes of about 35-50 mL per week. Usually, the expander is filled up to the point where the patient feels a sensation of tightness or some amount of discomfort. When too much normal saline is infused into the expander warning signs such as discolouration or blanching begin to appear. After 8-10 weeks of weekly expansion, the scalp tissue would have expanded sufficiently to allow wound closure.

Once the scalp has been expanded adequately, the next stage of reconstruction can be done. Initially, the expander is taken out from the fibrous capsule surrounding it. The scalp flap is then raised in the sub-galeal plane and rotated or

transposed as required to cover the defect and closed after placing a suction drain. If a residual defect is still present, re - expansion can be considered as a viable option but it has to be delayed for a period of at least 3 months to allow the wound to heal fully.

Disadvantages of tissue expansion are the prolonged time required for reconstruction, aesthetic unacceptability of the expanded site, chances of infection, risk of expander extrusion, hematoma formation and skin necrosis as a consequence of over expansion.



CRITERIA FOR IDEAL FLAP SELECTION FOR SCALP RECONSTRUCTION: ²⁴

- Size of the scalp flap should be adequate
- Texture of the flap should be similar to native scalp tissue

- The vascular pedicle has to be long and the anatomy should be consistent
- Flap dissection should be safe and simple
- Two team approach should be a possibility in case of free flaps to conserve time
- Donor site morbidity should be minimal

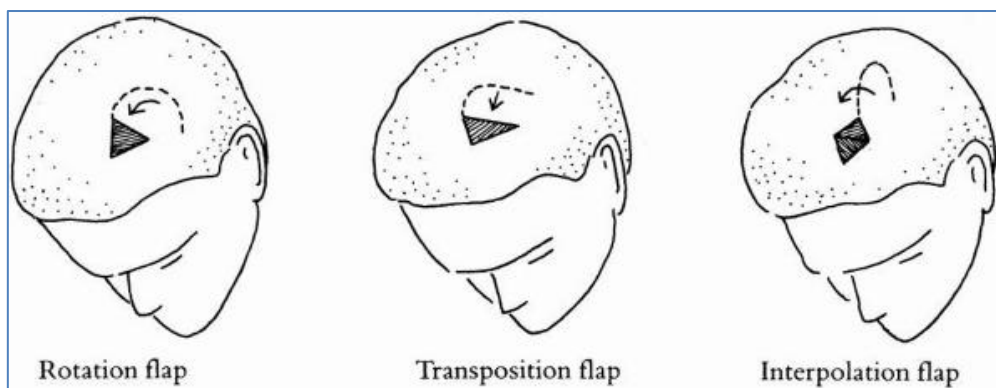
Local flaps

These flaps encompass the skin of the scalp, subcutaneous tissue and galea aponeurotica. Sometimes small defects which are superficial can be resurfaced adequately by a flap raised in the subcutaneous plane only.

Any local scalp flap can be best elevated over a named vascular pedicle. Designing a large flap and then resurfacing the donor defect using a split skin graft is probably the safest reconstruction method available. The final suture line should be planned in such a way that it should not lie over regions where prosthetic materials might get exposed.

The decision to use a transposition or a rotation flap is usually decided by the nature of the defect. Another factor influencing this decision is the size of the defect. When the

defect is large enough, a simple transposition flap ensures the greatest margin of safety because of direct, straight-line flow of the blood supply. A skin graft will be required to resurface the donor site defect. When the defect is small and closure of the secondary wound by primary suture is possible, the rotation flap facilitates the adjustment of tension and uneven wound margins.²⁵

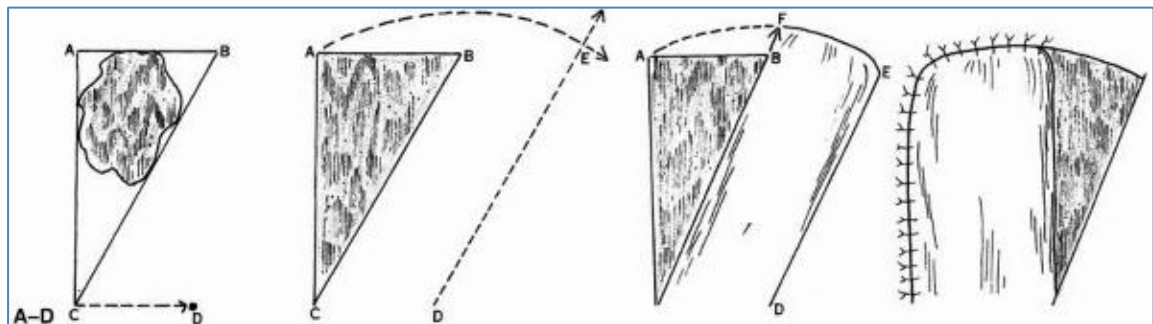


Transposition Flaps

This design offers the simplest and safest form of peninsular flap in that the axis of blood supply is compromised minimally. After the site of origin for a transposition flap has been determined, the recipient defect should be converted to an appropriate form, usually a triangular line of excision outside the borders of the defect. This triangle should be right-angled wherein the hypotenuse becomes the near margin of the flap.

The right angle of the defect assumes a position opposite the flap. The apex C should be directed toward the periphery of the scalp. The pivot point D will be located on a linear extension across the base of the flap parallel to AB at a distance from the apex at least equal to AB. From point D, a linear projection is developed parallel to AC. With point D as the axis, an arc is drawn from point A to the intersection with DE. The area ABF is excised after seating the flap in place.

The disadvantage of the traditional transposition flap is the inability to close the donor area. The closure of the donor defect would result in a force in the same direction as the flap movement, which is not possible. Thus, the defect requires supplemental coverage, usually in the form of a skin graft.²⁵



Design and transfer of Transposition flap



Pre – Op

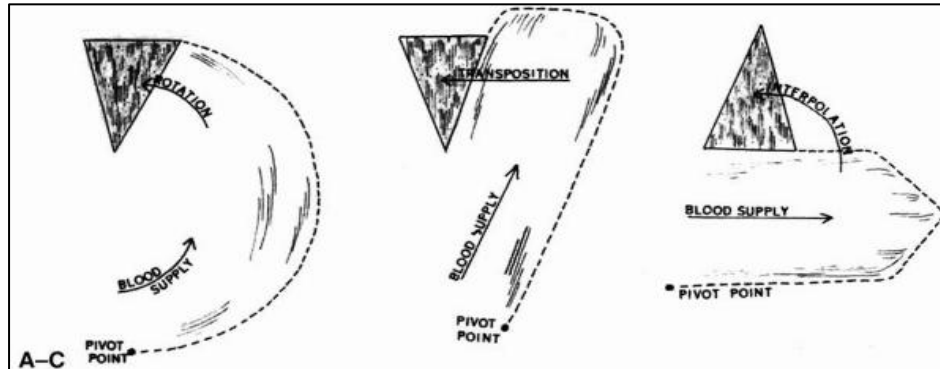


Post - Op

Interpolation Flaps

These flaps are similar to the transposition flap but differ in that the axis of blood supply rotates to a greater degree. Although this may introduce the question of vascular compromise, the interpolation flap offers the opportunity to close the donor site primarily, particularly if preceded by skin expansion.

The interpolation flap may be cut in any form and rotated through any arc desired, but it is characterized by “skipping over” normal scalp during the transfer.



Relationship between direction of flap transfer and arterial blood flow

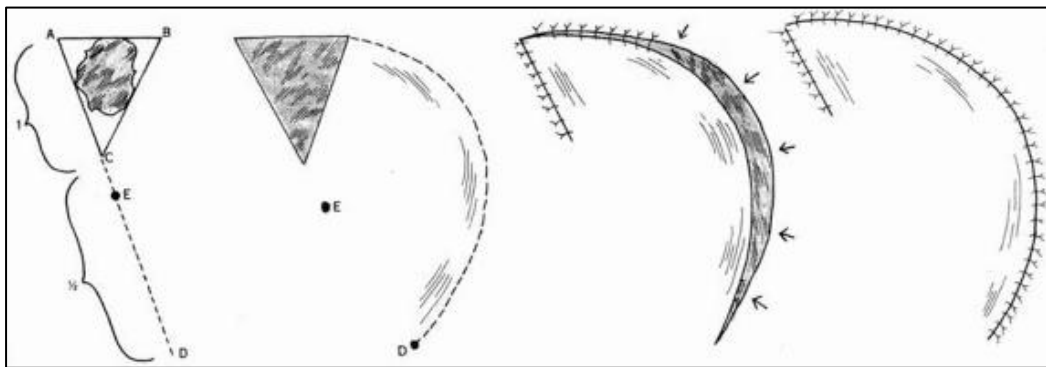
Rotation Flaps

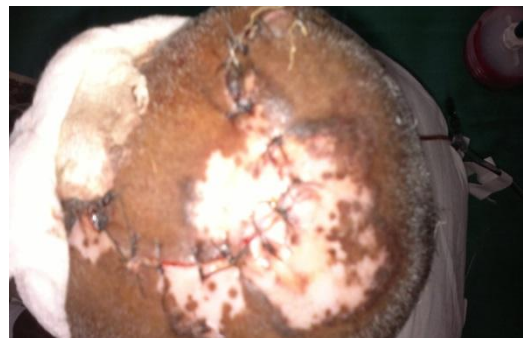
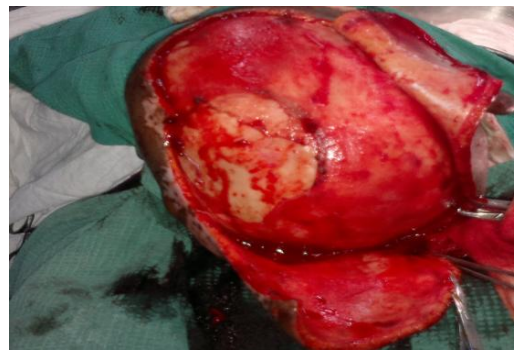
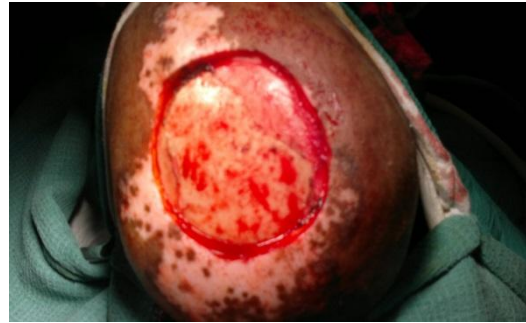
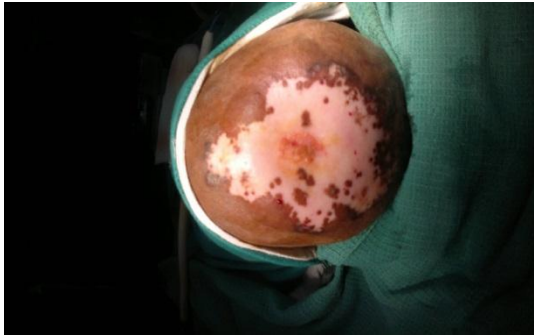
Preparation of the rotation flap again requires conversion of the defect to triangular form. In this case, the triangle must be isosceles with its apex C directed toward the base of the future pedicle of the flap. Apex C should be limited to an angle of 30 degrees to minimize “buckling” at this point after closure. Pivot point D will be located on a projection of line AC. Line CD must be at least 50% longer than AC. Midway between A and D, a point is designated, which becomes the

centre for an arc drawn from B to D that completes the outline for the flap.

This flap offers primary closure of the secondary defect by distributing tension over a wide and linear area.²⁵

Design and transfer of rotation flap





Bilateral Rotation flaps



Rotation – Advancement Flap



Orticochea flaps, or "banana peel flaps"

Scalp with central or vertex wounds often require multiple flaps to affect closure. Orticochea published his four flap scalp reconstruction technique based on known vascular territories of the scalp. He expanded these flaps by dividing the galea perpendicular to the direction of advancement. He subsequently modified the technique into a three flap reconstruction in 1971. Defects as large as 30% of the cranium can be closed by this three-flap technique, that peels the skin off the skull as one would peel a banana. This takes advantage of the excess skin that can be mobilized from the neck.

The incision that separates the two anterior flaps along the midline should be oblique, so that when the flaps are rotated

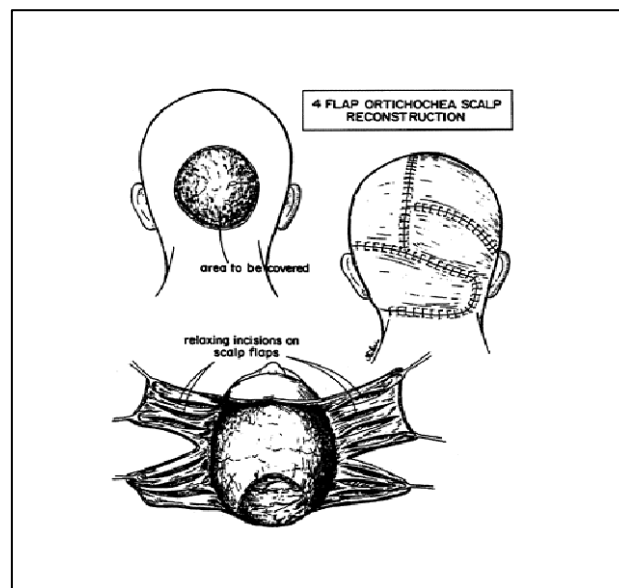
and slid back, they will fit up against the posterior transverse flap when it is moved up and forward.

The anterior flaps should be carefully undermined with blunt instruments, and great caution should be used when dissecting their pedicles, because the superficial temporal vessels and the posterior auricular vessels pass deeply and can be easily damaged.

The anterior flaps and the posterior transverse flap once mobilized, should be interpolated and sutured without being submitted to exaggerated tension. When extensive surfaces of the scalp are being reconstructed, it will be necessary to cover small raw zones with free skin grafts.

The advantage of the three-flap technique hinges on the size of flap 3. As half of the scalp is included within one large flap, better vascularity is obtained, and due to the broad pedicle, the flap can undergo a higher degree of traction than all the other smaller flaps. In fact, the flaps can be re-elevated and “re - expanded” 6 to 12 months later to aesthetically close large scalp defects.

The four-flap technique mobilizes the entire scalp and forehead skin to cover extensive scalp losses. Flaps 1 and 2 are stretched longitudinally and transposed over the defect, while flaps 3 and 4 are pulled back and stretched transversely to resurface the new raw areas.²⁵



Four flap Technique

Free flaps

Free flaps provide variety of tissues in adequate amount for reconstruction of scalp defects. They can be thin skin only flaps or thicker flaps that may comprise muscle or musculocutaneous flaps. Free tissue transfer requires micro vascular anastomoses to provide vascularity to the transferred tissue at the recipient site.

Free flap transfer mandates a good general condition of the patient and in order to give good micro vascular anastomoses requires good sized temporal artery and vein as these are the commonly used vessels for anastomoses.²⁶

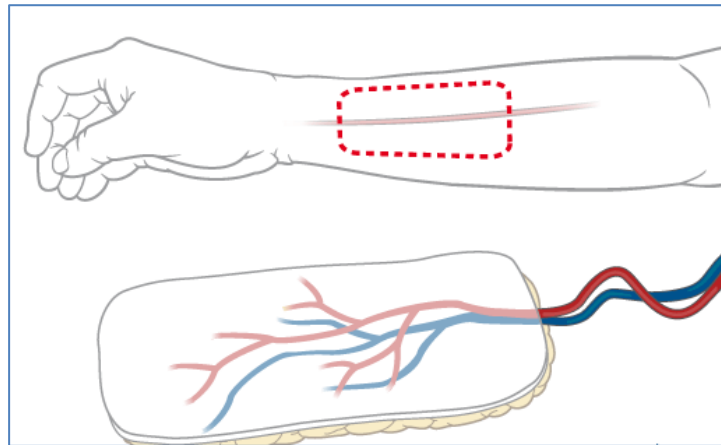
Radial forearm flap

The radial forearm free flap was introduced by Yang et al (1981). It has quickly become the workhorse free flap used in head and neck reconstruction.²⁶ The radial forearm free flap is, according to Cormack Lamberty classification, a type II fascio-cutaneous flap. This flap can be harvested easily with a long and reliable vascular pedicle which is anatomically consistent and is of large calibre.

The colour and texture match between the forearm and scalp tissue is good, and the skin is also quite durable. The flap area is limited and it can cover only 250 cm² area, which is not adequate for covering large defects. This drawback can be overcome with the use of tissue expanders which can expand the donor site prior to flap harvest.

Other disadvantages of the radial forearm flap are: significant donor site morbidity caused by the split skin

grafting and the risk of exposure of the flexor tendons at the donor site. This flap is indicated in thin and small scalp defects especially those of the forehead which cannot be reconstructed using other flaps such as the anterolateral thigh flap which are bulky and not suitable.²⁷



Radial forearm flap

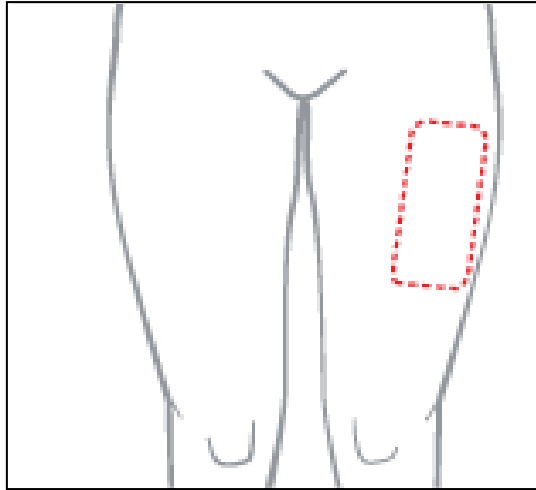
Anterolateral thigh flap

Song et al (1984) was the first to describe the Anterolateral thigh flap.²⁶ The anterolateral thigh flap is technically simple to raise and has a long and reliable pedicle. The vessel is of good calibre and is anatomically constant. This flap is indicated in cases with large scalp defects with a length up to 27 cm and breadth up to 18 cm. Primary closure of the donor site can be done provided the flap breadth does not exceed 8cm. In case of elderly patients it can be closed primarily up

to a width of 13cm.²⁶ Since most of the donor sites can be closed primarily the donor site morbidity is minimised.

Lutz BS in 2002 reported that ALT flap may be customized according to individual patient requirements and can be raised either as a cutaneous flap, myocutaneous flap along with the vastus lateralis or as a chimeric flap.²⁸

As the vascular anatomy is relatively inconstant, flap dissection can be technically difficult. Celik N et al in 2002 and Disa JJ et al in 2001 stated that dissection can be done safely if it is carried out in a retrograde fashion starting from the peripheral skin vessels and moving towards the main vessel.^{29, 30} In situations where the skin vessels are injured or if the main vessel is absent, it can be raised as an anteromedial thigh flap or as the TFL flap.²⁶ Patient can be completely mobilised on the first post op day.²



Anterolateral thigh flap



Pre Op



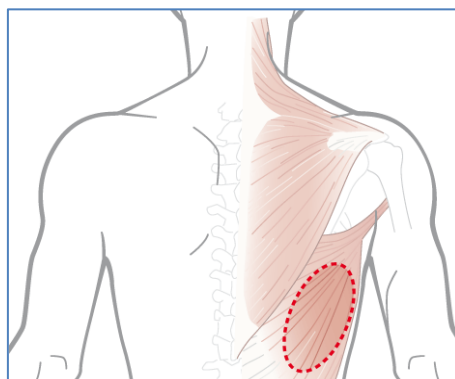
Post Op

Latissimus dorsi free flap

The latissimus dorsi free muscle flap is considered by many as the preferable option for reconstruction of large defects of the scalp. The free LD flap was first described by Maxwell et al in 1978.²⁶

The latissimus dorsi muscle is a wide, relatively thin and highly vascular muscle that suits cranioplasty reconstruction with autologous bone or using alloplastic materials.

Bostwick et al in 1979 stated that LD flap can be harvested as a myocutaneous flap, a muscle only flap covered with a split skin graft, as a functioning free muscle transfer or as a flow - through free flap.²⁷ The length of the pedicle is 10 cm if the subscapular vessels are also included while raising the flap. The muscle is usually raised as a muscle only flap without a skin paddle and can be covered with a split- skin graft for reconstructing scalp defects.



Latissimus dorsi free muscle flap

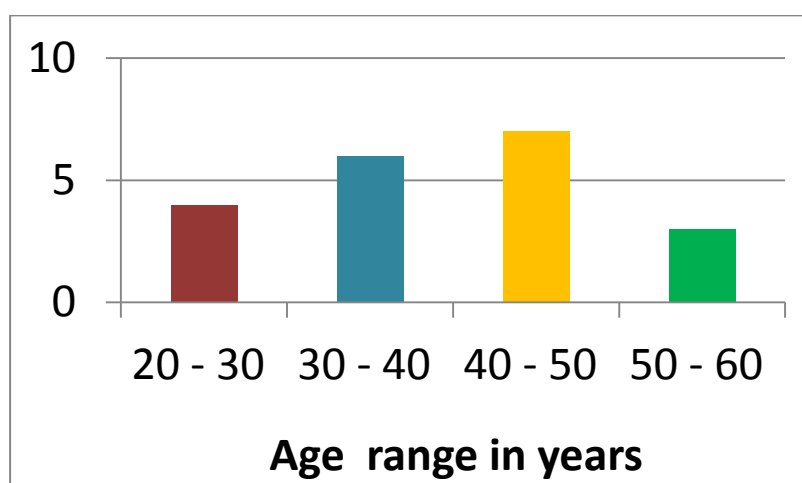
OBSERVATION AND RESULTS

A total no of 20 patients were included in the study over a period of 28 months between October 2010 to January 2013. Patient related, defect related and treatment related parameters were collected. Age in years, gender and comorbid illnesses were noted as patient related parameters. Wound aetiology was recorded as defect related factors. Phase of coverage, the mode of reconstruction and complications were taken as treatment related factors.

PATIENT RELATED PARAMETERS:

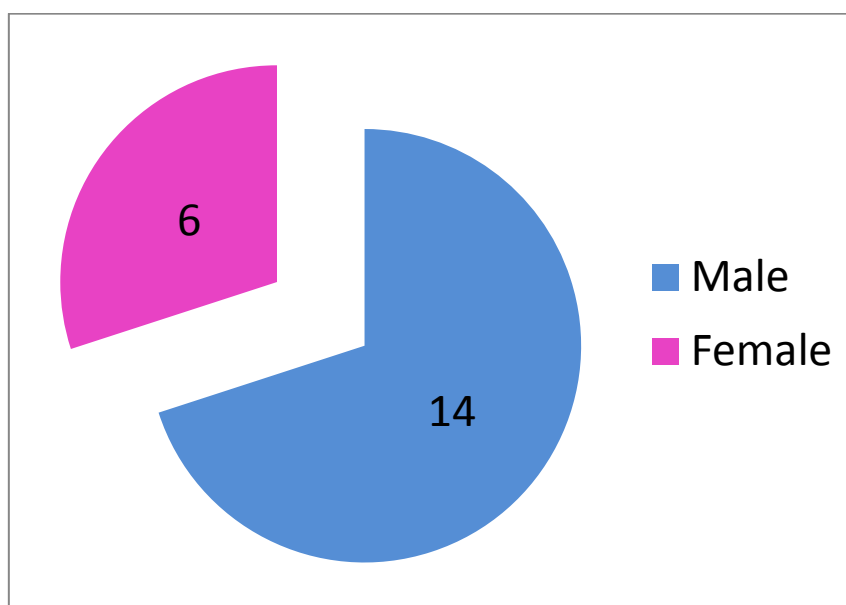
Table 1: Age range of the study subjects:

Age in range	Total no of Patients
20 to 30 years	4
30 to 40 years	6
40 to 50 years	7
50 to 60 years	3



Graph 1: Age range of the patients

Graph 2: Sex distribution of Patients



Comorbidity and Habits:

Among twenty patients, two patients were had diabetes mellitus and were taking regular medications, four patients were smokers, and one patient had the habit of consuming alcohol. (Table 2)

Table 2: Comorbidity and Habits:

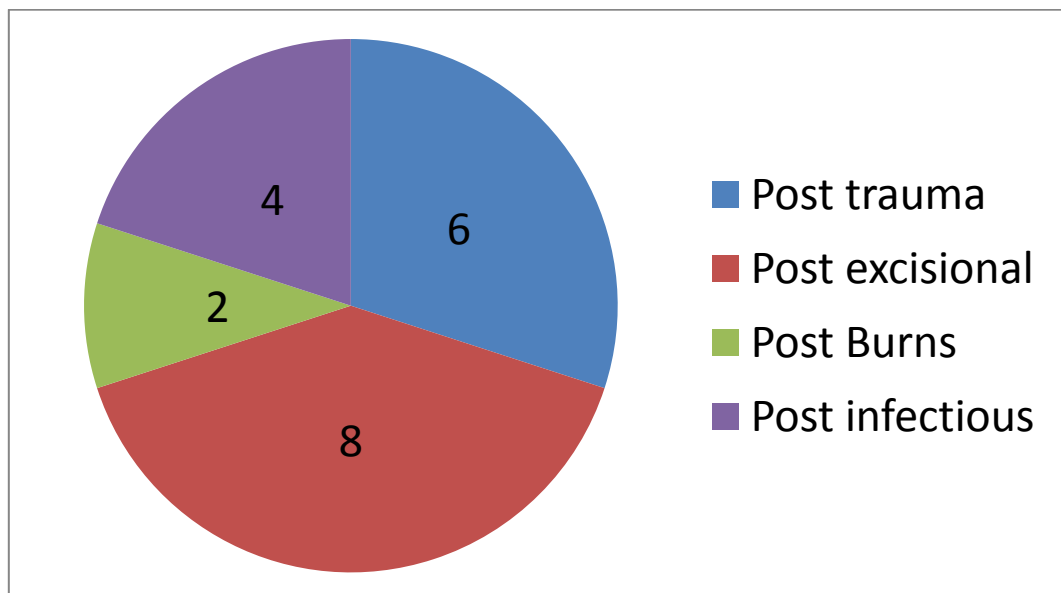
Diabetic	2
Smoking	4
Alcohol	1

DEFECT RELATED PARAMETERS:

Table 3: Etiological Incidence

S.no	Cause	No. of patients
1.	Post trauma	6
2.	Post excisional	8
3.	Post Burns	2
4.	Post infectious	4

Graph 3: Aetiology of Defects



TREATMENT RELATED PARAMETERS:

Phases of coverage of the defect:

In the present study highest number of flaps was done in the chronic phase (75%) and least flaps were done in the acute phase (10%).

Table 4: Phases of coverage:

Phases	Total no of patients
Acute phase (less than 72 hours)	2 (10%)
Sub – Acute phase (72 hours – 6 weeks)	3 (15%)
Chronic phase (beyond 6 weeks)	15 (75%)

Graph 4: Phases of coverage expressed in Percentage

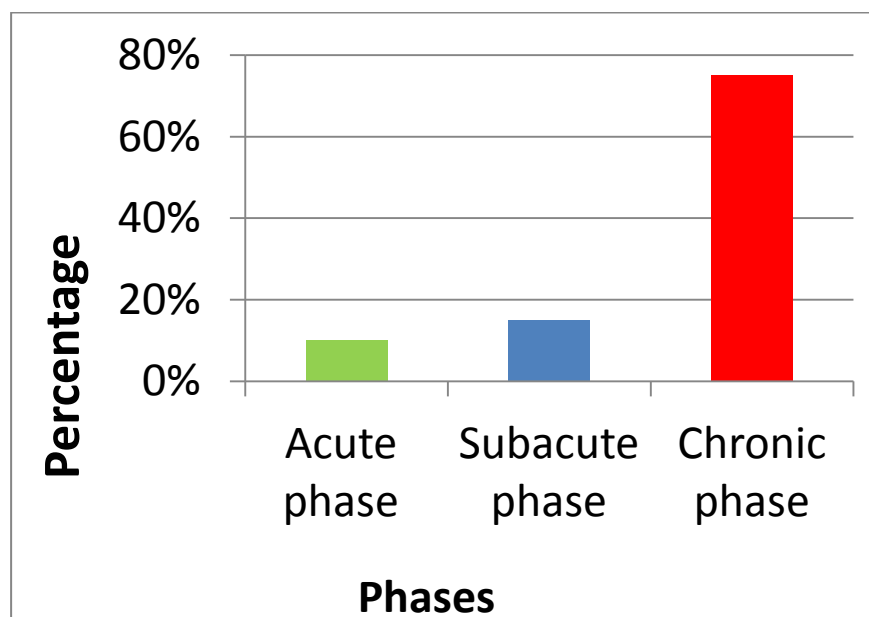


Table 5: Types of Reconstruction

Type of Reconstruction	Number done
Skin grafting	4
Rotation flap	10
Transposition flap	5
Tissue expansion	1
Free flap	2

Graph 5: Different types of reconstruction methods

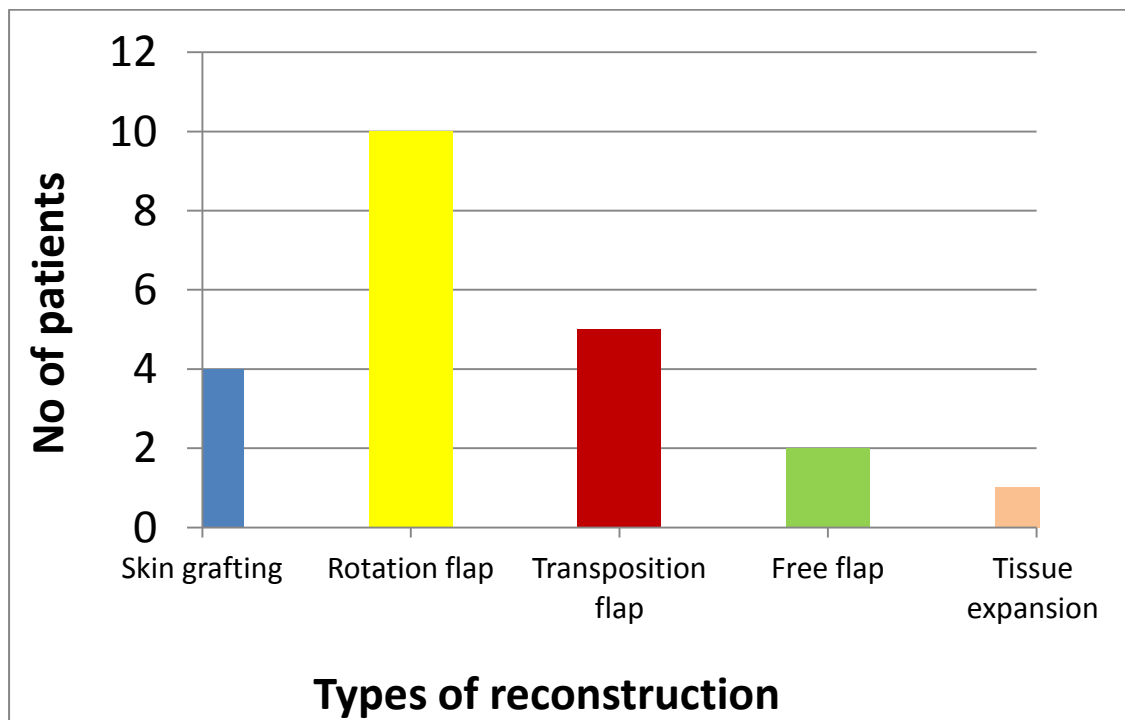
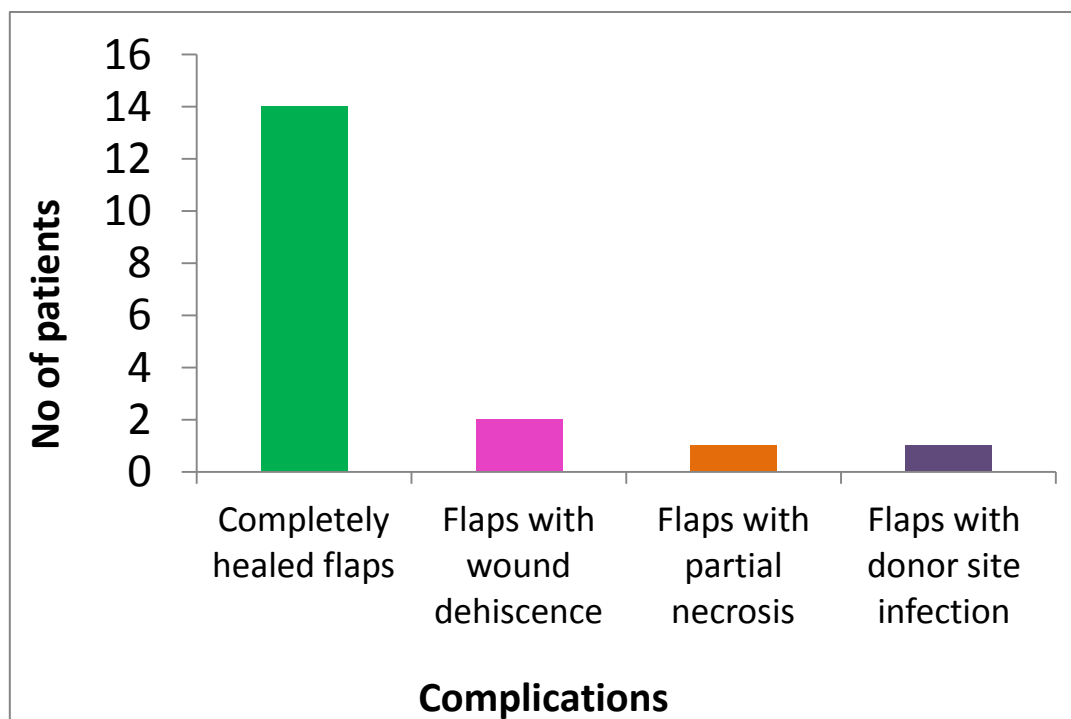


Table 6: Complications

No. of completely healed flaps	14
No. of flaps with wound dehiscence	2
No. of flaps with partial necrosis	1
No. of flaps with donor site infection	1
Total	18

Graph 6: Outcomes of the various methods of reconstruction



DISCUSSION

There are many considerations when formulating a treatment plan for a given patient with a scalp defect. Patient expectations and comorbid conditions need to be taken into account. Patient tolerance for certain procedures may limit their utility particularly in the case of prolonged tissue expansion. Far and away the best tissue for replacement of lost scalp is adjacent scalp tissue.⁸ Particular attention needs to be paid to the present hair distribution and its anticipated future.

Good knowledge about the anatomy of the scalp and its vascular distribution and the consideration of important factors such as the limited elasticity seen in the scalp tissues is paramount for a successful scalp reconstruction. Another aspect that has to be considered is the depth of the defects following resection and whether the calvarial bone is resected or left exposed. This fact has to be taken into account while planning the operative procedure.

Various etiological factors are responsible for scalp defects. Skin grafts and local scalp flaps have been used since long and are still considered whenever indicated. In our present study it was noted that skin grafts can be used for

scalp reconstruction only if the pericranium is present to give vascularity to the grafted site and this was in line with the findings of Shenoy et al in 1993.³¹

Split skin grafts can be used temporarily for covering the defect while the adjacent scalp tissue is prepared using tissue expanders and advancement flaps or for the pathological report to arrive in case of malignant tissue resections.

Skin grafting can also be used as an initial cover for the defect followed by sequentially excising the graft and covering it with an advancement or rotation flap containing hair-bearing scalp tissues. This method is very useful and can result in a good cosmetic outcome. But, the elasticity of the tissue decreases after each excision and scar alopecia is a disadvantage of this method.

Use of tissue expander facilitates direct defect closure with good aesthetic results. From the present study it can be noted that tissue expansion must usually be done prior to the excision of the lesion. Therefore, tissue expansion can be considered as a good option for reconstructing scalp defects arising from excision of benign lesions. These findings concur with the results of Newman et al in 2004.³²

The main disadvantage of tissue expansion is the length of treatment and involving two or more procedures. Pressure from the expander can cause moulding of the cranial vault and sometimes bony erosion. These findings are more pronounced in children. Hence tissue expansion cannot be used as a modality for malignant lesions and for traumatic and infected defects.

Local scalp flaps used for defect closure are mainly single or multiple rotation flaps with or without skin grafting for the donor site. Their advantage is reconstruction with stable, good texture, hair-bearing adjacent skin and soft tissues. Usually, local scalp flaps have minimal complication rate if the vascular distribution and anatomy of the scalp are taken into account while designing the flaps.

In the present study 16 patients underwent local or distant flap coverage for scalp defects and only one distal flap necrosis occurred. In this patient the defect was closed using multiple rotation flaps. This confirms the observations of Hoffmann JF in 2001 who stated that the risk of complication increases when multiple rotation flaps are used for the reconstruction of scalp defect .⁶

The chance of necrosis is minimal if not more than 2 large rotation flaps are used to cover the defect. The tissues covering the periosteum also have to be mobilised widely in order to cover the defect completely.

Local scalp flaps when planned meticulously are technically simpler than free flap reconstructive techniques. Local scalp flaps offer quick, easy and safe dissection. In the present study it was noted that 50 to 60% of the scalp area (moderate to large defects) can be covered easily using these local scalp flaps.

The disadvantages of local scalp flaps are that they require normal adjacent scalp tissue and need skin grafts to cover the donor defect which is aesthetically unacceptable. Also local scalp flaps cannot be used to cover forehead defects. Furthermore local flaps provide insufficient tissue to cover defects which are deep.

Free flap reconstruction has rapidly established itself as a desirable and versatile therapy for defects of the scalp, especially in larger and more complex cases. Scalp defects secondary to surgical resection of a cutaneous malignancy may necessitate reconstruction with a microvascular free flap.

Indications for microvascular free flap reconstruction include but are not limited to: defect size preventing primary closure, failed primary or local flap closure due to inelastic or poor skin quality, multiple resections for recurrences, or neo- or adjuvant radiation therapy.

The advantage and effectiveness of microvascular free flap reconstructive techniques depend on various factors including the underlying cause for the defect, the size of the defect, donor site morbidity, and involvement of surrounding structures. Beasley et al in 2004 stated that when the scalp defects measure greater than 200 cm², a free flap must be considered as the reconstructive option.³³

Free tissue transfer is a reliable and successful option for resurfacing large and complex defects of the scalp tissue. However, free flaps need microvascular setup, increased operative time, higher donor site morbidity and poor aesthetic outcome in hair bearing scalp. Chicarilli ZN et al reported that free tissue transfer can be done as a single stage procedure and gives stable cover with highly vascular tissues.³⁴ Foote et al in 1994 stated that free flaps can tolerate therapeutic doses of radiation as well.³⁵

Free flaps should be reserved for situations wherein local scalp flaps or split skin grafting cannot be done.

Despite the gross inequalities between these essentially different flap types, they have been included in a single study, as this study does not aim to assess the efficacy of any single flap. The study was only designed to highlight the various methods of scalp reconstruction procedures.

CONCLUSION

The following conclusions can be made from the present study:

- ❖ Certain factors are likely to influence the selection of reconstructive technique like the size and location of the defect in the scalp, whether the pericranium is intact to take up skin grafts, and quality of the adjacent scalp tissue.
- ❖ As the elastic property of the scalp tissue is limited, primary closure of scalp wounds should be done only for defects measuring less than 3 cm.
- ❖ In certain cases, if the pericranium is viable or the outer cortex is removed and the diploic space is exposed a skin graft can be used over the bone.
- ❖ Tissue expansion needs good amount of tissue that can be expanded, patient compliance for multiple procedures, and the calvarial cover should be stable in the expansion period.
- ❖ The vascular distribution within the scalp tissue should be taken into account when planning local scalp flaps.
- ❖ A good design for a local scalp flap should include major vascular pedicles. The flaps should be broad based and wound closure should be tension free.

❖ Microvascular reconstruction may be the most reliable option for reconstruction of large scalp defects, especially those that occur in compromised tissues.

The perfect reconstruction for every defect never exists; therefore, the reconstruction for every defect must be tailored to each case to perfection. A good knowledge of the anatomy, the individual patient, and the resurfacing choices that are available is the beginning, but the surgeon's success needs creativity to add all these elements together to give a satisfactory result for the patient.

BIBLIOGRAPHY

1. Jose Antonio Garcia del Campo, Jose Antonio Garcia de Marcos et al. Local flap reconstruction of large scalp defects. *Med Oral Patol Oral Cir Buca*, 2008 Oct1; 13(10): E666-70.
2. Camelia Tamas, Lucian Popa et al. Surgical reconstruction in scalp defects. *Jurnalul de Chirurgie, Iasi*, 2005, 1(2); 196 – 199.
3. Samuel J. Lin, M.D, Matthew M. Hanasono et al. Scalp and Calvarial Reconstruction. *Seminars in plastic surgery* 2008, 22 (4); 281 – 293.
4. Barbara S. Lutz, M.D. Scalp and Forehead Reconstruction. *Seminars in plastic surgery* 2010, 24 (2); 171 – 180.
5. Orticochea M: Four flap scalp reconstruction technique. *Br J Plast Surg* 1967, 20; 159
6. Hoffman JF. Management of scalp defects. *Otolaryngol Clin North Am* 2001; 34: 571–582.
7. Samuel J Beran MD. Scalp Reconstruction. *SRPS* 2001, 9 (15); 22 – 29.
8. Yadranko Ducic. Reconstruction of the Scalp. *Facial Plast Surg Clin N Am* 2009, 17; 177–187.

9. Charis Ioannides, Eric Fossion et al. Reconstruction for large defects of the scalp and cranium. *Journal of Cranio-MaxilloJacial Surgery* 1999, 27; 145-152.
10. Yoon S. Chun, Kapil Verma. Single-Stage Full-Thickness Scalp Reconstruction Using Acellular Dermal Matrix and Skin Graft. *Open access Journal of Plastic Surgery* 2011, 11; 28 – 33.
11. Furnas H, Lineaweaver WC et al. Scalp reconstruction by microvascular free tissue transfer. *Ann Plast Surg* 1990; 24: 431–44.
12. Robson MC, Zachary LS et al. Reconstruction of large cranial defects in the presence of heavy radiation damage and infection utilizing tissue transferred by microvascular anastomoses. *Plast Reconstr Surg* 1989; 83: 438–42.
13. Cemil Dalay, Erol Kesikbas et al. Coverage of scalp defects following contact electrical burns to the head: A clinical series. *Burns* 2006, 32; 201–207.
14. Manders EK, Schenden MJ et al. Soft-tissue expansion: concepts and complications. *Plast Reconstr Surg* 1984; 74: 493–507.
15. Leedy JE, Janis JE, Rohrich RJ. Reconstruction of acquired scalp defects: an algorithmic approach. *Plast Reconstr Surg* 2005; 116: 54e–72e.

16. Lutz BS, Wei FC et al. Reconstruction of scalp defects with free flaps in 30 cases. *Br J Plast Surg* 1998; 51:186–190.
17. Demir Z, Velidedeoglu H et al. V-Y-S Plasty for scalp defects. *Plast Reconstr Surg*. 2003, 112(4): 1054 - 8.
18. Cornelia Katharina Mueller, Rolf-Dieter Bader et al. Scalp Defect Repair A Comparative Analysis of Different Surgical Techniques. *Annals of Plastic Surgery* 2012, 68 (6); 594 – 598.
19. Bizhko IP, Slesarenko SV. Operative treatment of deep burns of the scalp and skull. *Burns* 1992; 18(3): 220–3.
20. Ioannides C, Fossion E, McGrouther AD. Reconstruction for large defects of the scalp and cranium. *J Craniomaxillofac Surg* 1999; 27: 145–52.
21. Beasley NJ, Gilbert RW et al. Scalp and forehead reconstruction using free revascularized tissue transfer. *Arch Facial Plast Surg* 2004, 6:16–20.
22. Kroll SS, Margolis R. Scalp flap rotation with primary donor site closure. *Ann Plast Surg* 1993; 30: 452–5.
23. TerKonda RP, Sykes JM. Concepts in scalp and forehead reconstruction. *Otolaryngol Clin North Am* 1997; 30: 519–39.
24. Pennington DG, Stern HS et al. Free-flap reconstruction of large defects of the scalp and calvarium. *Plast Reconstr Surg* 1989; 83: 655–61.

25. Grabbs encyclopedia of flaps. Scalp Flaps and the Rotation Forehead Flap. Chapter 1; 86 -93
26. Hussussian CJ, Reece GP. Microsurgical scalp reconstruction in the patient with cancer. *Plast Reconstr Surg* 2002; 109: 1828–34.
27. Mueller CK, Schultze-Mosgau. Radiation-induced microenvironments- the molecular basis for free flap complications in the pre-irradiated field? *Radiother Oncol.* 2009; 93: 581- 585.
28. Poeschl PW, Kermer C et al. The radial free forearm flap- prelaminated versus non-prelaminated: a comparison of two methods. *Int J Oral Maxillofac Surg.* 2003; 32: 159 - 166.
29. Thorwarth M, Eulzer C et al. Free flap transfer in cranio-maxillofacial surgery: a review of the current data. *Oral Maxillofac Surg.* 2008; 12: 113 - 124.
30. Corradino B, Di Lorenzo et al. Reconstruction of full thickness scalp defects after tumour excision in elderly patients: our experience with Integra dermal regeneration template. *J Plast Reconstr Aesthet Surg.* 2010; 63: 245 - 247.
31. Shenoy AM, Nanjundappa MS et al. Scalp flap-a utility reconstructive option for head and neck surgeons. *J Laryngol Otol* 1993, 107: 324.
32. Newman MI, Hanasono MM et al. Scalp reconstruction: a 15-year experience. *Ann Plast Surg.* 2004, 52(5): 501-6.

33. Beasley NJP, Gilbert RW et al. Scalp and forehead reconstruction using free revascularized tissue transfer. *Arch Facial Plast Surg* 2004; 6:16–20.
34. Chicarilli ZN, Ariyan et al. Single-stage repair of complex scalp and cranial defects with the free radial forearm flap. *Plast Reconstr Surg* 1986; 77(4): 577–85.
35. Foote RL, Olsen KD, Meland NB et al. Tumor ablative surgery, microvascular free tissue reconstruction, and postoperative radiation therapy for advanced head and neck cancer. *Mayo Clin Proc* 1994; 69:122–6.

APPENDIX – I

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI -3

Telephone No : 044 25305301

Fax : 044 25363970

CERTIFICATE OF APPROVAL

To

Dr.I.Prasanna,
P.Ch in M.Ch IIIrd Year,
Department of Plastic Surgery,
Madras Medical College, Chennai -3

Dear Dr.I.Prasanna,

The Institutional Ethics committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled "A clinical study on the various methods of Reconstruction of scalp defects" No.17022013.


The following members of Ethics Committee were present in the meeting held on 05.02.2013 conducted at Madras Medical College, Chennai -3.

- | | |
|---|---------------------|
| 1. Dr.SivaKumar, MS FICS FAIS | --- Chairperson |
| 2. Prof. R. Nandhini MD
Director, Instt. of Pharmacology ,MMC, Ch-3 | -- Member Secretary |
| 3. Prof. Shyamraj MD
Director i/c , Instt. of Biochemistry , MMC, Ch-3 | -- Member |
| 4. Prof. P. Karkuzhali. MD
Prof., Instt. of Pathology, MMC, Ch-3 | -- Member |
| 5. Prof. A. Radhakrishnan MD
Prof of Internal Medicine, MMC, Ch-3 | -- Member |
| 6. Prof. S. Deivanayagam MS
Prof of Surgery, MMC, Ch-3 | -- Member |
| 7. Thiru. S. Govindsamy. BABL | -- Lawyer |
| 8. Tmt. Arnold Soulina MA MSW | -- Social Scientist |

We approve the proposal to be conducted in its presented form.

Sd/ Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.


Member Secretary, Ethics Committee

APPENDIX – II

Turnitin Document Viewer - Google Chrome
https://www.turnitin.com/...
TNMGRMU APRIL 2013 EXAMINA... Medical - DUE 31-Mar-2013

What's New turnitin

6% SIMILAR
OUT OF 0

A Clinical study on the various methods of reconstruction of scalp defects
BY FRASANNA ILANGO 18102003 M.CH. PLASTIC RECONSTRUCTIVE SURGERY

Originality Grademark PeerMark

Window Snip

**A CLINICAL STUDY ON THE VARIOUS
METHODS OF RECONSTRUCTION OF
SCALP DEFECTS**

*Dissertation submitted in partial fulfilment of the requirements for
the degree of*

M.Ch. (Plastic Surgery) – Branch III

Page 1 of 82

No Service Currently Active



Your digital receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

Paper ID	313412109
Paper title	A Clinical study on the various methods of reconstruction of scalp defects
Assignment title	Medical
Author	Prasanna Ilango 18102003 M.Ch. Plastic Reconstructive Surgery
E-mail	meetprassi@gmail.com
Submission time	21-Mar-2013 09:21AM
Total words	8071

First 100 words of your submission

A CLINICAL STUDY ON THE VARIOUS METHODS OF RECONSTRUCTION OF SCALP DEFECTS D i s s e r t a t i o n submitted in partial fulfilment of the requirements for the degree of M.Ch. (Plastic Surgery) – Branch III THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY CHENNAI AUGUST 2013 1 INTRODUCTION The scalp being the superior border of the body, is many a times exposed to insults from the environment. As the scalp usually lacks clothing coverage, it is more commonly susceptible to burns and other trauma that cause extensive disfigurement and scarring. It is also the site for a variety of benign and malignant neoplasms, due to prolonged sun exposure. The factors influencing decision making in the repair of...

APPENDIX - III

PATIENT CONSENT FORM

Study Title: “A CLINICAL STUDY ON THE VARIOUS METHODS OF RECONSTRUCTION OF SCALP DEFECTS”

Study centre: Department of Plastic Reconstructive and Maxillofacial Surgery
Madras Medical College and Government Hospital, Chennai – 600003

Patient's Name:

Patient's Age:

Identification Number:

Patients may check (✓) these boxes

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask the questions and all my questions and doubts have been answered to my complete satisfaction. ()

I understand that my participation in the study is voluntary and I am free to withdraw at any time without giving reason, without my legal right being affected. ()

I understand that sponsor of the clinical study; others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the study. I agree to this access; however I understand that my identity would not be revealed. In any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ()

I agree to take part in the above study and to comply with the instruction given during the study and faithfully to cooperate with the study team, and to immediately inform the study staff if I suffer from any deterioration in my health or my well - being or any unexpected or unusual symptoms. ()

I hereby give consent to participate in this study. ()

Signature/ Thumb impression of the patient:

Place:

Patient's name and address:

Signature of the Investigator: Place..... Date.....

Name of the Investigator:

INFORMATION SHEET

We are conducting A CLINICAL STUDY ON THE VARIOUS METHODS OF RECONSTRUCTION OF SCALP DEFECTS on patients attending Plastic and Reconstructive and Maxillofacial Surgery Department at Government General Hospital, Chennai.

The purpose of this study:

1. To analyse scalp defects and to discuss the various established reconstructive options available and their application.
2. To evaluate the outcomes of various surgical procedures following scalp reconstruction.

The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of Investigator

Signature of Participant

APPENDIX - IV

PROFORMA

Name :

Age :

Sex :

I.P. No :

D. O.A :

D. O.S - :

D.O .D :

Complaints :

Etiology :

Trauma

Infection

Burns

Neoplastic

History :

Present illness :

Past illness :

General examination :

Systemic examination :

Local examination :

Defect analysis :

Site of the defect – Temporal

Frontal

Occipital

Parietal

Forehead

Dimensions of the defect

Thickness of the defect – soft tissue defect or composite defect

Status of surrounding skin

Other associated injuries

Diagnosis :

Treatment plan :

Investigations :

Operative procedure :

Post operative period :

Complications :

Follow up :

Secondary procedures :

KEY TO MASTER CHART

FF	-	Free flap
RF	-	Rotation flap
TF	-	Transposition flap
SSG	-	Split skin graft
TE	-	Tissue expander
PC	-	Primary closure
HC	-	Healed completely
WD	-	Wound dehiscence

S. No	Age	Sex	PS no	Etiology	Comorbidity	Habits	Defect size	Flap design	Donor area management	Complications
1	21	Male	1067/10	Trauma	Nil	Nil	14x8	FF	SSG	HC
2	33	Male	1433/12	Infection	Nil	Nil	8x6	RF	SSG	HC
3	42	Male	121/11	Post excision	Nil	Nil	10x6	RF	PC	HC
4	53	Male	245/11	Trauma	Nil	Smoking	14x9	SSG		Necrosis
5	37	Female	452/11	Post excision	Nil	Nil	12x7	TE	SSG	HC
6	47	Male	1031/11	Trauma	Nil	Nil	10x8	TF	SSG	HC
7	40	Male	1321/11	Post excision	Nil	Nil	6x5	RF	PC	HC
8	47	Male	1543/11	Infection	Nil	Smoking	11x7	TF	SSG	HC
9	39	Female	1612/11	Post excision	Nil	Nil	12x6	RF	SSG	WD
10	48	Male	1815/11	Burns	Nil	Smoking	16x7	FF	SSG	HC
11	20	Female	1965/11	Trauma	Nil	Nil	30x20	SSG		HC
12	43	Female	86/12	Burns	Nil	Nil	20x12	SSG		HC
13	31	Male	239/12	Infection	Nil	Nil	7x5	RF	PC	WD
14	55	Male	321/12	Trauma	Diabetic	Nil	12x8	SSG		HC
15	44	Female	654/12	Post excision	Nil	Nil	15x9	RF	SSG	HC
16	24	Male	806/12	Trauma	Nil	Alcohol	13x10	RF	SSG	Infection
17	57	Male	983/12	Post excision	Diabetic	Nil	9x6	TF	SSG	HC
18	35	Female	1398/12	Post excision	Nil	Nil	8x5	RF	PC	HC
19	46	Male	1564/12	Infection	Nil	Smoking	9x8	TF	SSG	HC
20	28	Male	1812/12	Post excision	Nil	Nil	11x9	RF	SSG	HC

ஆராய்ச்சி தகவல் தாள்

- சென்னை அரசு பொது மருத்துவமனை ஒட்டுறுப்பு அறுவை சிகிச்சைப் பிரிவில் வரும் நோயாளிகளிடம் தலைத்தோற் பகுதியில் ஏற்படும் பல்வேறு குறைபாட்டினை சரி செய்யும் அறுவை சிகிச்சை முறைகளும் அதன் வெளிப்பாடுகளும் பற்றிய ஆய்வு நடைபெறுகிறது.
- நீங்களும் இந்த ஆராய்ச்சியில் பங்கேற்கலாம்.
- முடிவுகளை அல்லது கருத்துக்களை வெளியீடும் போதோ அல்லது ஆராய்ச்சியின் போதோ தங்களது பெயரையோ அல்லது அடையாளங்களையோ வெளியிட மாட்டோம் என்பதையும் தெரிவித்துக்கொள்கிறோம்
- இந்த ஆராய்ச்சியில் பங்கேற்பது தங்களுடைய விருப்பத்தின் பேரில் தான் இருக்கிறது. மேலும் நீங்கள் எந்நேரமும் இந்த ஆராய்ச்சியிலிருந்து பின்வாங்கலாம் என்பதையும் தெரிவித்துக்கொள்கிறோம்
- இந்த சிறப்புப் பரிசோதனைகளை ஆராய்ச்சியின் போது அல்லது ஆராய்ச்சியின் முடிவின் போது தங்களுக்கு அறிவிப்போம் என்பதையும் தெரிவித்துக்கொள்கிறோம்.

ஆராய்ச்சியாளர் கையொப்பம் பங்கேற்பாளர் கையொப்பம்

தேதி -

ஆராய்ச்சி ஒப்புதல் கடிதம்

ஆராய்ச்சி தலைப்பு -

தலைத்தோற் பகுதியில் ஏற்படும் பல்வேறு குறைபாட்டினை சரி செய்யும் அறுவை சிகிச்சை முறைகளும் அதன் வெளிபாடுகளும் பற்றிய ஆய்வு.

பெயர் - தேதி -

வயது - நோயாளி எண் -

ஆராய்ச்சி சேர்க்கை எண் -

இந்த ஆராய்ச்சியின் விவரங்களும் அதன் நோக்கங்களும் முழுமையாக எனக்கு தெளிவாக விளக்கப்பட்டது.

எனக்கு விளக்கப்பட்ட விஷயங்களை புரீந்து கொண்டு நான் எனது சம்மதத்தைத் தெரிவிக்கிறேன்.

இந்த ஆராய்ச்சியில் பிறரின் நிர்பந்தமின்றி என் சொந்த விருப்பத்தின் பெயரில் தான் பங்கு பெறுகிறேன் மற்றும் நான் இந்த ஆராய்ச்சியிலிருந்து எந்நேரமும் பின்வாங்கலாம் என்பதையும் அதனால் எந்த பாதிப்பும் ஏற்படாது என்பதையும் புரீந்து கொண்டேன்.

தலைத்தோற் பகுதியில் ஏற்படும் பல்வேறு குறைபாட்டினை சரி செய்யும் அறுவை சிகிச்சை முறைகளும் அதன் வெளிபாடுகளும் பற்றிய ஆய்வு ஆராய்ச்சி தாளைப் பெற்றுக் கொண்டேன்.

அறுவை சிகிச்சை செய்வதற்கு முன் வலி தெரியாமல் இருக்க மயக்க ஊசி முதுகில் போடுவதற்கு சம்மதம் தெரிவிக்கிறேன்.

மேற்கண்ட ஊசியை போடும்போதோ அல்லது அறுவை சிகிச்சை செய்யும்போதோ செய்யும் ஏதேனும் பின் விளைவுகள் ஏற்படலாம் என்பதையும் மருத்துவர் மூலம் அறிந்து கொண்டேன்.

கையொப்பம்